The Chemical Nature of Matter

7-5 The student will demonstrate an understanding of the classifications and properties of matter and the changes that matter undergoes. (Physical Science)

7-5.8 Explain how a balanced chemical equation supports the law of conservation of matter.

Taxonomy level: 2.7-B Understand Conceptual Knowledge

Previous/Future knowledge: In 6th grade (6-5.2), students explained how energy can be transformed from one form to another in accordance with the law of conservation of energy. Students have not been introduced to the concept of the law of conservation of matter in previous grades. Students will further develop this concept of balanced chemical equations and conservation of mass in high school Physical Science (PS-4.7).

It is essential for students to know that the amount of matter does not change during a chemical reaction, only that the atoms are rearranged to form new substances.

- The *law of conservation of matter* states that matter can neither be created nor destroyed, but can be changed in form.
- Because matter is neither created nor destroyed, the total mass of the material(s) before the reaction is the same as the total mass of material(s) after the reaction.
- A *balanced chemical equation* has the same number of each kind of atom on the reactant side as on the product side.
- To determine whether a chemical equation is balanced, two numbers are considered: the subscript (7-5.7) and the coefficient.
- A *coefficient* is the number that comes before the chemical formula and indicates the number of particles that participate in the reaction.
- In order to determine whether an equation is balanced, multiply the number in front of the chemical formula in the equation (coefficient) by the number written below the symbol for the element(s) (subscript) in the formula. If no coefficient is written, it is understood to be one. For instance, for "$2H_2O$" there are 4 hydrogen atoms and 2 oxygen atoms.
- The number of each kind of atom on the left side of the arrow must equal the number of each kind of atom on the right side of the arrow for the equation to be balanced.

For example, in the chemical equation for the reaction of water (liquid) breaking into hydrogen (gas) and oxygen (gas) as represented by the balanced chemical equation:

$$2H_2O \rightarrow 2H_2 + O_2$$

- There are four hydrogen atoms on the reactant side (coefficient of 2 x subscript 2) and four hydrogen atoms on the product side (coefficient 2 x subscript 2).
- There are two oxygen atoms on the reactant side (coefficient 2 x (understood) subscript 1) and two oxygen atoms on the product side ((understood coefficient 1 x subscript 2).
- There are the same number of hydrogen atoms (4) and oxygen atoms (2) on both sides of the equation; therefore, the equation is said to be balanced.
- Since there are the same number of each kind of atom on both sides of the arrow and atoms represent kinds of matter, the amount of matter is the same on both sides of the equation, which supports the law of conservation of matter.

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It is not essential for students to know how to determine coefficients to balance chemical equations. They must only recognize that an equation is balanced. They do not have to know how to create the chemical formulas for substances. They must only analyze given formulas for common substances to determine the number of each component part. Substances with polyatomic ions (for example, $(NH_4)_2CO_3$ ammonium carbonate) as part of their chemical formula are not the intent of this indicator.

Assessment Guidelines:

The objective of this indicator is to *explain* how a balanced equation supports the law of conservation of matter; therefore the primary focus of assessment should be to construct a cause-and-effect model of how the number of atoms of elements on reactant side of the equation must equal the number of atoms of elements on the product side of the equation. However, appropriate assessments should also require students to *recall* the law of conservation of matter; *recognize* whether or not a chemical equation is balanced or not; *identify* the coefficient in a chemical equation; or *summarize* how the law of conservation of matter relates to a balanced equation.